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8 April 1966

THE SUPERSONIC TRANSPORT AS AN INSTRUMENT OF NATIONAL POWER

By

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DONALD I. HACKNEY ^{U.S. ARMY WAR COLLEGE}

Lieutenant Colonel, United States Air Force



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THE SUPERSONIC TRANSPORT AS AN INSTRUMENT
OF NATIONAL POWER

by

Lt Col Donald I. Hackney
USAF

US Army War College
Carlisle Barracks, Pennsylvania
8 April 1966

SUMMARY

In this study, the impact of the supersonic transport on national power is examined in terms of benefits derived economically, militarily, psychologically, and technologically. Emphasis is placed on the effect the supersonic transport could have on the national economy and balance of payments and the potential military application.

Through a recent comprehensive Government evaluation of specific design proposals, it was determined that design and production were technically feasible and the transport would have safe and efficient operating characteristics. Based on these verified characteristics, the economic potential of the supersonic transport is analyzed in some detail since the success of the program rests on the degree of economic viability that can be achieved in operational service.

Primary international competition will come from the British/French Concorde, although the Soviet entry may be surprising since they have apparently changed their program from one of "first with anything" to an approach seeking outstanding economic characteristics.

The U.S. program is most likely three or more years behind the Concorde. Such an extended period could draw sales away from the U.S. product which would reduce the U.S. market, cause deteriorating economics and run the risk of an expensive program failure. On the other hand, a U.S. program which moves ahead in an expedited, orderly manner could cause a substantial financial loss for the British and the French because of the superior competitive position of the U.S. supersonic transport.

A compromise will not insure success for both the U.S. and the British/French product because of the uncertainties of international competitive forces. It is therefore, concluded that timing is the critical factor affecting the success of the U.S. program.

In view of the significant impact a successful supersonic transport program could have on our own national power, it is recommended that the U.S. program be accelerated.

Since the supersonic transport could strengthen our national military airlift capability and provide a highly productive vehicle for other military missions, it is further recommended that a comprehensive study be made to determine specific military applications.

It is quite conceivable that an orderly, deliberate development program for the supersonic transport could lead to the finest transport in the history of aviation. And this can be done at no cost to the taxpayer.

FOREWORD

Soon after the introduction of today's subsonic jetliners, aeronautical researchers here and abroad began to consider the application of supersonic flight to the ever-expanding air transportation system. This was a logical step since each generation of air transports has flown higher and faster with improved service to the public while significantly raising the level of safety.

Consideration of a national development program for a supersonic transport began in the United States Government in 1959. The formal program was launched in 1961 when Congress provided \$11 million to initiate the applied research phase.

Under the leadership of the Federal Aviation Agency, a unique staff has been formed for managing the supersonic transport program. The Director of the program as well as several members of the staff are active duty U.S. Air Force Officers with extensive backgrounds in aircraft systems development. Some of the staff came from key positions in the aircraft industry, some came from the National Aeronautics and Space Administration, some from the Navy, and of course, some from various elements within the FAA. The author was assigned to this office from 1961 to 1965. Prior to this assignment, he had a total of seven years experience in the systems engineering and management field related to the development of military aircraft, subsonic and supersonic.

Analysis of the technological, economic, and management problems associated with any future course of action and the impact

alternative courses will have in the national interest is based on the experience outlined above. Knowledge of the relative merits of proposed designs is explicitly excluded since a design has not been selected from competing companies. Further, the relative merit of competing designs is immaterial to this study.

The United States program is still in the design phase. According to the current schedule, the prototype construction phase would not begin until early 1967. Operational service would not commence prior to 1974.

In view of the above, the supersonic transport is a relatively new subject. Reference material is, therefore, scarce. Although articles appear from time to time in newspapers and magazines, Congressional hearings and a few FAA documents remain as primary source material. To the knowledge of the author, this is the first paper that deals with the supersonic transport as an instrument of national power.

CHAPTER 1

INTRODUCTION

National power determines to a large extent the ability or inability of a nation to achieve its national objectives. A nation's own security as well as its role and influence in international affairs are a function of its national power. The elements of power of a nation--political, economic, military, psychosocial, and scientific-technological--are interdependent. One depends on the other and in turn is affected by the other. For example, there could be no strong military without a sound and growing economic base. On the other hand, a strong military allows economic and political forces freedom of operation. Science and technology are also dependent on a strong economic base and in turn have a significant effect on the economy.

National power is not attained through any one element but requires the balancing and strengthening of all elements of power--economic well-being, political stability, social progress, military security, and scientific-technological know-how.

The purpose of this study is to examine the role of the United States supersonic transport as an instrument of national power. Although the supersonic transport could have important implications both psychologically and technologically, the principle questions to be examined in this study are what impact could it have on the national economy and balance of payments and what are the potential military applications.

The implications of national importance of the supersonic transport were first expressed by President Kennedy in his announcement to initiate the development program. At the Air Force Academy commencement exercises on June 5, 1963, he said this Government "should immediately commence a new program in partnership with private industry to develop at the earliest practical date the prototype of a commercial supersonic transport superior to that being built in any other country in the world." He described supersonic transportation as "the challenging new frontier in commercial aviation" and said it was "essential to a strong and forward-looking nation."¹

Less than five months after President Johnson took office, he established the President's Advisory Committee on Supersonic Transport by signing an Executive Order on April 1, 1964. The order read in part:²

Whereas the United States has initiated a program for the development of commercial supersonic aircraft; and

Whereas supersonic transport will advance technical knowledge, expand our international trade, strengthen our manufacturing capability, and provide employment for thousands of our citizens; . . .

In addition, there have been numerous Congressional hearings on the supersonic transport and since August 1961, \$231 million

¹U.S. Congress, House, Subcommittee on Independent Offices Appropriations, Supplemental Appropriation Bill, 1961, Civil Supersonic Transport Development, pp. 44-45 (referred to hereafter as "Congress, Supersonic Transport").

²Ibid., pp. 48-49.

have been appropriated. Congress appropriated \$31 million for the research phase and, up to now, has appropriated \$200 million for development.

This brief summary of Presidential and Congressional words and actions related to the national importance of the supersonic transport gives rise to a further and deeper analysis of the impact it will have on national power.

CHAPTER 2

THE NATURE OF THE PROGRAM

Since the supersonic transport program was initiated in 1961, program management has been under the leadership of the Federal Aviation Agency working in close cooperation with the National Aeronautics and Space Administration, the U.S. Air Force and the Civil Aeronautics Board. However, in April 1964, control of the program was assigned to the Secretary of Defense as Chairman of the President's Advisory Committee on Supersonic Transport.

The program is an unique Government/industry program and must be put into perspective. It is a commercial program with Government assistance. Development cost is estimated to be \$1 - 1.5 billion¹ which compares with \$200-\$300 million for a large subsonic transport development.² Only because of the magnitude of the development cost is Government assistance required. It is not a military program.

Aside from safety, then, economic viability must be the first and foremost consideration in a commercial program. All benefits and military applications which could be derived from the supersonic transport are dependent on the success or failure of the program as a sound business-like commercial venture.

¹U.S. Federal Aviation Agency, United States Supersonic Transport Program Questions and Answers, Jul. 1965, p. 6 (referred to hereafter as "FAA, SST Q & A").

²U.S. Congress, Senate, Aviation Subcommittee of the Committee on Commerce, United States Commercial Supersonic Development Program, p. 502.

It is therefore incumbent upon the Government to keep the program as near to the normal commercial enterprise system as possible. The ultimate user, the airlines, must continue to play a strong consulting role. In view of potential profits, the manufacturers must bear a reasonable share of the financial risk involved in the development. In addition, the sales price to the airlines must include an amount sufficient to cover not only the manufacturers share of development but also to repay the Government's share of development costs, including interest. This puts the project back into the realm of a commercial venture. The pay-back to the Government must be considered in determining the economic viability of the transport since direct Government subsidy in any form would constitute failure.

Once the technical and economic feasibility of the supersonic transport is determined under the broad conditions outlined above, management of the program becomes one of the key elements in insuring that the transport is economically attractive in actual operation. Ups and downs and "stretch-outs" have continually plagued military programs in terms of added cost and delays in going into operation. It must be realized, however, that these conditions are sometimes due to purely military factors such as changes in operational requirements, the possibility of obtaining a more effective alternate weapon system, or the need to keep "open options" until threats are verified. These factors would hardly be applicable to the commercial supersonic transport. Barring some insurmountable, and as yet unknown, technological problem,

serious delays can be minimized through capable leadership and strong Congressional support.

As mentioned earlier, the magnitude of the development cost precludes industry and the airlines from proceeding on a normal risk/profit basis. The pace of the program, therefore, is controlled by the Government instead of market forces and business judgement. Under these conditions, the Government bears a tremendous responsibility not only to the taxpayers but to the aircraft and airline industries which could suffer serious losses due to delays.

Program delay in a purely military development is serious. In a commercial program such as the supersonic transport, delays could cause complete program failure due to increased costs and loss of sales to international competition. Increases in development costs and added interest caused by delays could have a significant effect on the sales price and operating economics. A less attractive product will limit the market which in turn would cause a further increase in sales price and further deteriorating economics. Coupled with this would be more purchases by the airlines from foreign producers in order to remain competitive while waiting on a U.S. product. This further detracts from the market, and the adverse effect on economics is intensified.

The spectre of an enormous and expensive "white elephant" should be feared more from indecision and program delay than from moving ahead with a prototype program. Only through the latter

approach will the "hard-core" problems be determined and successful solutions found on a timely basis.

The program is unique. How does the Government assist with appropriations and the required supervision evolving from use of public funds and yet keep the program as close to the normal free enterprise conditions as possible? It will take just the proper degree of both for a successful program. The program cannot be managed as a normal Government development project.

New ideas, new approaches, imagination, initiative, and decisions are required if the United States is to move ahead in this important undertaking which could have far reaching effects in the national interest.

The former FAA Administrator in discussing supersonic travel as air transport's next great step summarized progress in aviation in this manner:

The United States is the world aviation leader, an eminence which is the product of many factors: gallantry and stamina in the air, genius and hard work on the ground, proud achievements and brave decisions in plants, offices and board rooms.³

The United States has never found itself lacking in gallantry, stamina, genius or hard work. These attributes have made our nation what it is today. The airlines, the aircraft industry, and indeed the nation need only the challenge and the opportunity.

Whether the "board room" is ever returned to an agency of the Government for program management and planning, or kept in a committee

³Najeeb E. Halaby, "Air Transports' Next Great Step - Supersonic Travel," Aerospace, May 1962, p. 1.

under the Secretary of Defense as it is today, "brave decisions" are required or leadership in world aviation will be handed over to someone else at considerable loss to the nation.

In July 1965, on the recommendation of the President's Committee, the design phase of the U.S. program was extended 18 months to bring the program to the prototype-construction phase. The President announced that the Committee believes that "with future work on the basic technological problems, a commercially profitable supersonic transport can be developed" and that "much work must be done before construction of a prototype aircraft is initiated--if the large financial and development risks underlying the program are to be minimized."⁴

The extended design effort means that the prototype-construction phase will begin almost 3 1/2 years after the Request for Proposals establishing the design and performance objectives was issued to industry in August 1963. It will be 2 years after technical and economical feasibility of a specific design was determined by a comprehensive Government evaluation. It will be almost 5 years since the first group of specific SST research contracts were let in April 1962, and close to 20 years since the first manned supersonic flight in October 1947.

In terms of supersonic experience, the United States had, by early 1965, more than 150,000 hours of experience at flight over the speed of sound and more than 10,000 hours at or above twice

⁴Congress, Supersonic Transport, p. 44.

the speed of sound. Data is also being fed into the supersonic transport program from the Mach 3 Air Force YF-12A and B-70 flight programs. It has been estimated that the U.S. aviation manufacturing industry has, in the aggregate, more than 100 company-years of experience with supersonic planes.⁵

With years of specific SST research and development effort by both industry and the Government and a wealth of supersonic flight experience, one might logically question the pace of the U.S. program. Under the announced schedule, the prototype construction phase would not begin before early 1967.

Meanwhile, other nations are moving ahead with their supersonic transport programs. The British-French Concorde prototype program is in the "hardware" stage with first flight set for early 1968.⁶ The development cost is estimated to be more than \$800 million.⁷

This is a large investment even by U.S. budget standards. The importance that the British and the French governments attach to the development of a supersonic is exemplified by their determination to commit some \$400 million each.

⁵U.S. Federal Aviation Agency, United States Supersonic Transport Program, Chronology - Brief History - Research Contract Summary, Jul. 1965, p. 32 (referred to hereafter as "FAA, SST History").

⁶Edgar E. Ulsamer, "Prestige and Profits - The Stakes in the SST Race," Air Force and Space Digest, Jan. 1966, p. 46.

⁷Secor D. Browne and William Barclay Harding, "The National Interest in Supersonic Transport," Technology Review, Jan. 1965, p. 1.

The Concorde apparently enjoys a rather high priority. It has been reported that of the \$81 million available for civil aviation in France this year, President DeGaulle has allocated \$79 million to the Concorde.⁸

Although the Soviet Union has never been successful in developing commercial aircraft as indicated by practically no sales, their interest in the supersonic transport field is apparently substantial. The 1965-66 issue of the authoritative Jane's All the Worlds Aircraft predicts that a prototype of the Soviet TU-144, a 121 passenger supersonic transport may be flying in 1968, the same date set by the Concorde. According to Jane's, with the Russians as well as the British/French cutting metal, "the prospect is hardly pleasing for American industry which regards itself, with justification, as a pacemaker in commercial aviation."⁹

The crux of the problem, however, is not who flies first. The crux of the problem is how far behind is the United States.

This is not to belittle the importance of who flies first because considerable benefits will accrue. In the case of the U.S.S.R., prestige, recognition, and the favorable impact psychologically it will have on the new nations of the world will be the most important gains. In the eyes of the new nations, the Soviet Union would again be first in a major scientific-technological achievement. Admittedly, this could have at least a significant short-term effect in an era of competing national systems.

⁸"Parade," Washington Post, 14 Nov. 1965, p. 19.

⁹John W.R. Taylor, ed., Jane's All the Worlds Aircraft, 1965-1966, p. i.

In the case of the British and French being first, or even ahead of the United States, psychological benefits will accrue in addition to the more important prospect of capturing the market at the expense of the United States.

If the United States program is not too far behind the Concorde and a superior U.S. transport is produced, then the United States could be the real winner. The favorable impact such a program would have on national power in terms of economic expansion, balance of payments, military applications, and its effect psychologically and technologically must be weighed against the possibility of substantial financial loss for the British and French governments. On the other hand, a compromise in our program could result in a major loss for the United States, not only economically but militarily, psychologically, and technologically.

These factors as well as others will be considered in analyzing the current program. A brief program summary is presented only to establish a basis for the current program. The economic potential of the supersonic transport will be examined in some detail since the success or failure of the program rests on this important factor.

CHAPTER 3

PROGRAM SUMMARY

In May 1960, the House Committee on Science and Astronautics held the first major hearings on the supersonic transport. Principal findings in a report by the Committee were that (1) development of the supersonic transport (SST) would be in the national interest and (2) Congress should provide financial assistance.¹

The purpose of this Chapter is to briefly highlight the more important elements of the program since 1960 so that an analysis can be made of the technological, economic, and management problems associated with any future course of action and the impact alternative courses will have in the national interest. Before any analysis can be made, however, the question of technical and economic feasibility must be examined.

ORIGIN

In March 1961, on the recommendation of Federal Aviation Administrator, N. E. Halaby, President Kennedy requested \$12 million from Congress to initiate the supersonic transport research program. The program envisioned at the time was a two-year effort of about \$50 million to study the technical and economic feasibility and to lay the applied research groundwork for moving into a development

¹U.S. Congress, House, Committee on Science and Astronautics, Supersonic Air Transports, pp. 23-24.

program. The initial aim of the program was to make a recommendation by late FY 1963 as to whether or not to proceed with a Government-assisted development program.

This approach had considerable merit. It set a time limit on "study" prior to a decision to go into the development phase. It hoped to preclude a long drawn-out expensive research and component development phase before a decision is made to go ahead or terminate. Studying a program to "death" is not uncommon. The Aircraft, Nuclear Propulsion (ANP) Program is a prime example.

After fifteen (15) years of feasibility studies and research and development effort, the ANP Program was terminated in March 1961, at a total cost of about \$1.040 billion. The General Accounting Office, in a report to Congress stated that, "an airplane had never been flown on nuclear power nor had a prototype airplane been built."² The FAA Administrator and the President sought to avoid any such fate for the supersonic transport.

In June 1961, a joint FAA-NASA-DOD working group prepared the first formal program document to present a synthesis of views of both the Government and industry on the technical, financial, and programming aspects of the supersonic transport. The report stressed the requirement for a safe, economically competitive airplane and suggested a cruising speed of approximately Mach 3.³

²General Accounting Office, Review of Manned Nuclear Propulsion Program, Feb. 1963, p. 2.

³U.S. Dept of Defense, National Aeronautics and Space Administration, Federal Aviation Agency, Commercial Supersonic Transport Aircraft Report, Jun. 1961, pp. ii,iii,35.

Congress was also busy at this time with the \$12 million request. The House approved \$10 million. The Senate committee recommended the restoration of the \$2 million reduction, so the amount remained \$12 million before the full Senate.

During the Senate hearings⁴ it was made clear that the aviation industry would finance a portion of the development costs and a substantial recovery of the Government's share would be realized by means of royalties paid by the private purchasers. But, Senator Symington was concerned about the development of a commercial Mach 3 airplane while at the same time the DOD had indicated it did not plan to use additional appropriated funds for the military Mach 3, B-70. He finally offered an amendment to eliminate the \$12 million.

A vote was taken and the result was announced - yeas 35, nays 35. So Senator Symington's amendment was rejected.

With the Senate, therefore, at \$12 million and the House at \$10 million, the bill was referred to conference and comprised at \$11 million. Thus the SST program, on a rather shaky start, was formally initiated by Congress when \$11 million was appropriated to the FAA in August 1961.

The next year, \$25 million was requested and \$20 million approved. The two-year research effort was therefore based on \$31 million.

⁴U.S. Congress, Senate, Independent Offices Appropriations, 1962, Hearings, Congressional Record, 29 Jul. 1961, pp. 14021-14029.

RESEARCH PHASE

Technical feasibility of developing an airplane to fly at Mach 3 was well established by the B-70 program. Economic and operational requirements of the SST, however, established new technical requirements. The SST must be efficient not only at supersonic speeds but also at the off-design subsonic speeds.

The applied research effort included investigations in such areas as aerodynamics, structures and materials, aeroelastic and loads research, systems, propulsion, fuels, controls, sonic boom, noise, fuel reserves, air worthiness standards, and air traffic control.

Active participation in the program by FAA, NASA, USAF, airlines and leaders of other elements of the aviation community insured a comprehensive and well-coordinated effort. The industrial and scientific might of the nation was brought to bear on the technological problems. During the two-year research program thirty-seven contractors were awarded one or more contracts.⁵

The Government's problem was to intelligently review and evaluate all of the available information so that a judgement and decision on the development program could be made in the latter part of FY 1963 as originally planned.

At the end of 1962, President Kennedy established a Cabinet-level Committee under then Vice President Johnson to review the

⁵FAA, SST History, op. cit., p. 30.

Government-industry research program and SST feasibility. In addition to the research program, two significant study group reports were available to the Committee. The report of a Task Force on National Aviation Goals recommended:⁶ The U.S. Government should pursue a vigorous applied research and engineering program to establish preferred design parameters for a supersonic transport aircraft-- Government funds should be utilized through the research, design, development, prototype and probably production stage.

A report by the Supersonic Transport Advisory Group in December 1962, recommended "expeditious development of a commercial supersonic transport."⁷

Although the second phase of the two-year research program was just beginning at the time of the Johnson Committee deliberations during May 1963, there were indications of substantial progress. Based on a review of all available data, the Johnson Committee recommended a "go-ahead." With President Kennedy's announcement on June 5, 1963, of the decision to initiate design of a U.S. SST, the program moved into the development phase.

INITIAL DEVELOPMENT PHASE

The primary purpose of this section is to review the results of the two major evaluations of proposed designs during the initial development phase. Proposals were submitted by industry in January

⁶U.S. Federal Aviation Agency, Project Horizon Report, p. 17.

⁷FAA, SST History, op. cit., p. 38.

1964 and in November 1964, in response to the Government's original Request for Proposals (RFP) issued on August 15, 1963.⁸ Three air-frame companies, Boeing, Lockheed, and North American, and three engine companies, Pratt and Whitney, General Electric and Curtiss Wright submitted their initial design proposals on January 15, 1964.

The principal goal established by the RFP was economic operation comparable to the best of today's subsonic jet transports.

Although the design was left to the manufacturers, certain operational limitations in the area of noise, sonic boom, and airport compatibility were included. The most critical of these from a design standpoint were the sonic boom objectives of 2.0 pounds per square foot (psf) maximum for acceleration and 1.5 psf maximum for cruise. Based on both scientific and social analyses, these limits were considered a reasonable compromise between what the public might accept from an annoyance standpoint and what was feasible from a design standpoint.

To evaluate the proposed designs, the FAA organized a highly competent, joint Supersonic Transport Evaluation Group numbering 210 specialists from FAA, NASA, the Air Force, Navy Civil Aeronautics Board, and Department of Commerce. This group conducted a comprehensive analysis and evaluation of the design proposals in the technical, operational, management and economics areas.

The evaluation was completed in the Spring of 1964, and it was at this point that President Johnson established the Advisory

⁸U.S. Federal Aviation Agency, Request for Proposals, 15 Aug. 1963.

Committee on Supersonic Transport with the Secretary of Defense as Chairman.

After receiving an evaluation report from the FAA Administrator, President Johnson summarized the results in a memorandum back to him which stated in part:

As you have reported to me, however, the 210 member Government evaluation group after analyzing the proposals in depth, found that none of the proposed airframe designs met the minimum range-payload requirements of the FAA request for proposals of carrying a 30,000 pound payload for a distance of 4,000 statute miles, moreover, none of these designs met what you properly emphasized as a basic requirement; namely, that the aircraft be capable of economic operation.⁹

Obviously, more design work would be required before going into the prototype phase. The President directed that contracts be awarded for further design work, and on June 1, 1964, the FAA let 6-month contracts with Boeing, Lockheed, General Electric, and Pratt and Whitney at about \$1 million each per month.

The second major evaluation of specific design proposals was conducted in November 1964. Again, experts were called in from NASA, the Air Force, the Navy, and the CAB, to form an integrated evaluation team. Wind tunnel testing of models was accomplished at the Langley Research Center as a part of the performance analysis. The propulsion system was evaluated at the Air Force Propulsion Laboratory by a joint team of Air Force, NASA, and FAA experts. Development and production costs were evaluated by a team consisting

⁹ Congress, Supersonic Transport, op. cit., p. 49.

primarily of Air Force and Navy experts. Estimated costs were based on data associated with specific designs, not on empirical formulas to give rough estimates. The economic analysis included consideration of performance, direct operating costs, indirect operating costs, and return on investment.

The results of this evaluation were summarized by the FAA Administrator on January 26, 1965, before the Committee on Science and Astronautics of the House of Representatives. The Administrator indicated that significant progress had been made by industry and stated:

This evaluation has definitely established a supersonic transport that can carry a payload in excess of 40,000 pounds for 4,000 statute miles, and do so at a seat-mile cost that at transcontinental and greater ranges is something less than current seat-mile costs of today's best long-range subsonic jet liners.

The second round evaluation, moreover, strongly indicates that there are no significant technical problems that cannot be overcome in an orderly development program in the time that will be available to us.¹⁰

The state of technology and economic feasibility was corroborated by the present FAA Administrator, General W. F. McKee, USAF (Ret), in August 1965, before the House Subcommittee on Independent Offices Appropriations.¹¹ In referring to the second Government evaluation in November 1964, General McKee described the evaluation

¹⁰U.S. Congress, House, Committee on Science and Astronautics, Status of U.S. Supersonic Transport Program, Jan. 1965, p. 42 (referred to hereafter as "Congress, Status of SST Program, Jan. 1965").

¹¹Congress, Supersonic Transport, op. cit., pp. 8-14.

group as one "composed of outstanding engineers" and stated, "It was their judgement, at the completion of the November evaluation that the supersonic transport design will be both safe and capable of profitable operation in airline service."

Elaborating on the capability of profitable operation, the Administrator continued:

Evaluating the design, under economic ground rules that were reviewed by the airlines and the manufacturers, it appears that this transport in commercial service will demonstrate a return on investment in the neighborhood of from 20 to 30 percent annually after taxes and before interest.

In regard to technology, General McKee stated:

At this point in the program, however, we do not see any technical problem associated with the transport which cannot be overcome through intensive effort, utilizing the best of the extensive technical resources of this country.

For the first time during the course of the supersonic transport program, significant and favorable results were revealed through a comprehensive evaluation of specific design proposals. The basic findings were available in December 1964, after the November evaluation, and made known publicly by the FAA Administrator in January 1965. Obviously, one or both of the competing companies were in a position to step up the design pace. The program, however, was kept in "limbo" for six months for the Committee to review the program, and then the Committee recommended an 18-month extension of design effort.

CURRENT PHASE

On July 1, 1965, President Johnson announced the determination that the supersonic transport program should move into an 18-month phase of accelerated design work by industry to bring the program to the prototype construction phase. (This is a \$220 million effort; \$140 million for FY 1966 and \$80 million for the first half of FY 1967).

The President acted on the basis of the second interim report of the President's Advisory Committee on Supersonic Transport under the Chairmanship of the Secretary of Defense. After reviewing the findings of the November 1964 evaluation and reports of continued design work, the Committee recommended an 18-month program based on the two airframe and two engine design contractors in the program being invited to continue in this phase.¹²

Although the FAA Administrator had reported to the House Committee on Science and Astronautics that the second design evaluation of November 1964 showed significant progress and demonstrated feasibility of a technically, economically sound SST, the President's Advisory Committee concluded that it would take 18 more months of continued design effort before entering the prototype construction phase.

Primary objectives of the 18-month program are:¹³

¹² Congress, Supersonic Transport, op. cit., pp. 43-44.
¹³ Ibid., p. 44.

First, to provide a sound foundation upon which realistic estimates of operating performance and development of production costs can be based.

Second, to take advantage of the flight experience of the SR-71, the XB-70, and the variable swept wing F-111--all of which will be extensively flown at supersonic speeds during the next 18 months.

Third, to reduce development risks and development costs, while retaining the capability to accelerate the program in its later phases, depending upon the technological progress of the manufacturers.

And fourth, to provide a basis for judgement as to the manner in which the program should proceed after the 18-month period, and to determine with much greater precision and knowledge the work that should be done in the succeeding phases of the program.

As of July 1965, the decision to build a United States supersonic transport had not been made.

From a technical standpoint, based on evaluation results, the 18-month extension of design effort would have to be considered a rather cautious approach with minimal funding. For 18 months each of four contractors, two airframe and two engine, will expend approximately \$3 million per month. This follows a period of 12 months where each of the four expended approximately \$1 million per month.

By the end of the current phase, the competing companies will have been funded for 2 1/2 years at comparable levels. They will have been funded for 2 years at comparable levels since one or both

specific design proposals were found acceptable. This type of program could easily make the ultimate decision more difficult since the designs may "converge." For example, two years of funding at comparable levels could hold one competitor back while allowing another to catch up.

Just what the 18-month extension of design effort means in terms of operational dates is uncertain but there are indications of a stretch-out. Before the announcement was made, the 1972-1973 time period for commercial service was generally accepted. The present estimate is more like 1974-1975.

In announcing the results of the November 1964 evaluation to the House Committee on Science and Astronautics, in January 1965, the FAA Administrator said the design contractors are thinking in terms of having a transport ready for commercial service in 1972 or soon thereafter, provided there is an early decision to go ahead.¹⁴

After the announcement of the 18-month extension, the present FAA Administrator, General William F. McKee, in an address to the Aero Club of Washington in October 1965, indicated the goal of the FAA was for certification of the SST by 1974.¹⁵ The July 1965, FAA Question and Answer booklet estimated "certification of the production aircraft in 1973-1975."¹⁶

¹⁴Congress, Status of SST, Jan. 1965, op. cit., p. 45.

¹⁵James R. Ashlock, "SST Firms to Receive USAF Aircraft Data," Aviation Week, 22 Nov. 1965, p. 33.

¹⁶FAA, SST Q & A, op. cit., p. 7.

By comparison, the Concorde operational date had generally been accepted as 1971, but Pierre Satre, France's senior engineering executive on the Concorde, is apparently a little more optimistic and specific. In a recent address before the International Congress on Air Technology, he was quoted as saying that by 1970, the program will have accumulated 5,000 hours of flight, hopefully leading to certification of the Concorde in that same year.¹⁷

The pace of the U.S. program and the resulting time-lag behind the Concorde will have a significant impact on the economic potential of the U.S. supersonic transport.

¹⁷Edgar E. Ulsamer, "Prestige and Profits--The Stakes in the SST Race," Air Force and Space Digest, Jan. 1966, p. 46.

CHAPTER 4

ECONOMIC POTENTIAL

The U.S. SST is being designed to be the most productive aircraft ever built. An indication of the potential productivity can be realized from some of the major characteristics of the proposed U.S. SST's.

Both Boeing and Lockheed designs currently have a cruise speed of Mach 2.7 (1780 miles per hour) and use titanium alloys as the primary structural material. The aircraft should have a 15-year life in commercial service.

The designs currently provide for 200 to 250 passengers and have maximum take-off gross weights in the order of 500,000 pounds. In normal commercial operations the supersonic transport should be capable of being serviced at a through stop in 30 minutes and at turnaround points in one hour and thirty minutes. Both designs meet the criteria of being able to operate safely from today's airports which accommodate the large subsonic transport. The operating speeds in approach and landing at the airport and in taking off should be no greater than the speeds of today's large subsonic jets, and in addition, the transport must be capable of meeting the requirements of the traffic control system which will be in effect in the 1970's.¹

¹Congress, Supersonic Transport, p. 29.

The Boeing design incorporates a variable-sweep wing similar to that of the F-111 in an attempt to maximize efficiencies at both subsonic and supersonic conditions. The Lockheed design uses a fixed, "double delta" wing.

Although some of the basic characteristics are similar, there could be significant differences in their economic potential. At the sake of over-simplification, it could be stated that the key economic characteristics, operating cost and return on investment, are functions of two main factors, fuel burned and sales price. Fuel burned, directly related to the aerodynamic, propulsion, and structural efficiencies, greatly influences the cost and range/payload capability of a specific design. In addition, pricing policies of the competing airframe and engine companies, in large measure, influences the sales price.

The earning power and economic potential of a specific design are derived from integration of the performance and economic characteristics into a route-system operation including both short and long range flights. From this, the rate of return on investment is determined.

The remarks of the present FAA Administrator indicating a possible return on investment between 20 and 30 percent for the SST in commercial service is most significant. Return on investment is an all-inclusive index of profitability. It is a reflection of such factors as development costs, production costs, market, sales price, cost of initial spares, range/payload capability, operating efficiencies, direct and indirect operating costs, passenger

fares or yields, interest, taxes, royalties, and operation of the transport within a route system, domestic or international.

An indication of profitability, however, would not alone insure a successful program. Many other factors must be considered. Safety, of course, is of paramount importance. Other factors such as noise, sonic boom, and airport compatibility are very important. Extensive work has been done in all three areas and it appears that with continuing effort these three problem areas would not seriously jeopardize the success of the program. All must be considered, however, in relation to the economic potential of the SST.

The range/payload capability determines the revenue potential and it is especially critical in the long-haul international system. Significant progress has been made in this important factor. As previously indicated, none of the proposed designs met the minimum range/payload requirements initially, but the second evaluation, in November 1964, showed a range/payload capability of more than 40,000 pounds for a range of 4,000 miles and at seat mile costs equal to or less than the best of today's jet transports at the longer ranges. Although design progress was no doubt substantial, it should be noted that the sonic boom requirements, which directly affect performance have changed since the original RFP. The FAA Administrator in August 1965, indicated that for stage lengths in excess of 3,000 statute miles, which are expected to be over water in most cases, the sonic boom limitation during acceleration will be 2.5 psf.² This factor alone, 2.5 psf vs the original 2.0 psf

²Ibid., p. 9.

requirement, could have a significant effect on improving the range/payload capability for the long range international operation.

The sales price, as a function of production costs, development costs, profit, and warantees, must be held to a reasonable level. Historically, the prices of military aircraft has been greater than predicted principally due to program delays and changes in design. Aside from matters of safety, no change should be made in the SST unless it can be justified on an economic basis. For example, an increase in sales price resulting from a major modification must be justified through greater efficiency of operation or greater revenue potential derived from a larger payload capability.

The Government is not the customer and has not ordered "X" number of aircraft. The airlines are the customer, and the manufacturer cannot afford to price himself out of the market. The commercial incentive exists to insure a reasonable price. An efficient product must be produced to capture sales with or without foreign competition.

Technology applied to production techniques for various vendor and supplier items as well as machine tools will play an important role in minimizing the sales price. But even the large companies will find it difficult to invest in such capabilities without some assurance of a production program phased in with the development program. Such assurance has not been forthcoming. Indeed,

what happens after the 18-month design extension was not even indicated at the time the extension was announced.

The potential market will also have a significant effect on the sales price, and all indications point to a very substantial market--provided the U.S. product is not too late.

The original RFP as well as the current "Economic Model Ground Rules"³ stipulate a basic 200 aircraft production run as the basis for sales price estimates. The economic potential of the SST has been based on this market figure.

Today, the estimate of 200 appears ultra-conservative. The FAA now predicts an estimated market for over 400 United States supersonic transports in the 1980's and a market potential that could exceed 800 aircraft in the 1990's.⁴

The Department of Commerce, which was assigned to study the economic aspects of the program in addition to the work of the FAA, was even more optimistic. In a recent report, Commerce predicted worldwide sales of 1,000-1,500 aircraft.⁵

With these strong indications of market potential and favorable operating efficiencies, it would be well to examine the predicted return on investment of 20 to 30 percent.

³U.S. Federal Aviation Agency, Supersonic Transport Economic Model Ground Rules, SST 65-7 (Rev), Sep. 1965, p. 4 (referred to hereafter as "FAA, Ground Rules").

⁴FAA, SST Q & A, p. 4.

⁵James R. Ashlock, "Johnson Advises Split in SST Financing," Aviation Week and Space Technology, 11 Oct. 1965, p. 36.

The Civil Aeronautics Board provides a return on investment guide for airline operation--not for a single type aircraft but for the airline as a whole. In a recent airline fare case, the CAB noted that in the General Passenger Fare Investigation decision of 1960, a 10.5% return on invested capital was set as fair and reasonable for an airline.⁶

To determine what the SST should make, several assumptions must be made. Since the SST will be the long-haul "prime route" aircraft of an airline fleet, it would be reasonable to assume that it would account for at least 60% of the traffic miles. Even if the other type aircraft of the fleet serving the short haul market do nothing more than break-even, the SST would require approximately 16% for the airline to meet 10.5%. Raising this estimate 25% to account for invested capital other than for aircraft, the requirement of the SST becomes in the order of 20%. This is a very "rough" analysis which is intended only to give an approximation based on the assumptions.

From this analysis, then, the return on investment goal for the SST would be in excess of 20%. In view of this, the FAA estimate of 20 to 30% should be very attractive from an airline point of view.

The computation method for return on investment, outlined in the FAA Economic Model Ground Rules, is comparable to that required

⁶James R. Ashlock, "United Jet Fare Rejection Shakes Industry," Aviation Week and Space Technology, 6 Sep. 1965, p. 34.

of the airlines in reporting to the CAB. It is based on current yields (passenger fares less discounts), current dollars, and simplified airline system operations. The domestic route system with flight segments that average 500 to 2500 miles is based on an average system distance of 1455 miles with a 55% load factor. The international system is based on an average system distance of 1980 miles with a 50% load factor. Numerous other performance and economic factors are contained in the Ground Rules.⁷

Alternate computation methods for return on investment such as the discounted cash flow technique are available and have been used. This method takes into account the time value of money. In other words, a present dollar is worth more than a future dollar since the present dollar could be accruing interest and be worth more than a future dollar. This method is especially attractive in analyzing alternate investments which are diverse and extend over different time periods. It could also be used as a check for the SST to insure that the equivalent discount or interest rate is greater than that which could be obtained from a pure capital investment for interest. Once this is done, and since the two competing SST's represent comparable investments over the same period of time, the basic method of the FAA appears most appropriate. Either method however, would indicate the degree of economic potential although the answers would be different.

⁷ FAA, Ground Rules, op. cit., entire document.

Even though the feasibility of building a SST with excellent economic characteristics has been demonstrated through a comprehensive evaluation, it is recognized that much development work is required before placing a new aircraft into commercial service. But with an estimated 20 to 30% return on investment based on an ultra-conservative market, there appears to be sufficient "pad" to insure the required economic viability. Indeed, it is possible that a return greater than 20% could result in general fare reductions.

Quite conceivably the SST could become the finest transport in the history of aviation not only for commercial aviation, but as a military transport as well.

CHAPTER 5

MILITARY APPLICATION

If a successful supersonic transport is developed and enters regular airline service, it follows that it will also be used by the military. The advantages of speed, productivity, and economic operation will be available to the military at no direct development expense.

The Air Force has always been interested in going higher, farther, and faster to enhance its operational capability. From time to time, specific interest has been expressed in a supersonic transport but a requirement has never been established by the Department of Defense.

During Senate hearings in October 1963, Dr. Harold Brown, then Director of Defense Research and Engineering, stated that, "at present, the Department of Defense has no established requirement for a supersonic transport."¹ This position is clear and to a degree understandable.

The position was taken in October 1963, before the first proposals were submitted. It was quite natural at that point in time for people to be skeptical, if not pessimistic, concerning SST capabilities. The first evaluation proved the skeptics were

¹U.S. Congress, Senate, Aviation Subcommittee of the Committee on Commerce, United States Commercial Supersonic Development Program, P. 216.

right. The second evaluation, however, has given rise to a more optimistic view by most people intimate with the program.

Based on expected characteristics in 1963, military benefits apparently never justified the expenditure of at least \$1 billion in development funds and possibly \$25 million each for production aircraft. Under the present program, to satisfy a commercial requirement, the Government's share of development expense can be returned through royalties paid by the airline purchasers. With this approach, both the DOD and the taxpayers stand to gain.

According to Dr. Brown, the Secretary of Defense considered the question of whether the Department of Defense should take the leading role in the development and he decided not to "on the basis it wasn't for us. It was for the civilian market, it should meet civilian standards and therefore should be managed by the civilian agency."²

Ironically, seven months after the statement was made, control of the program was vested in the Secretary of Defense as Chairman of the President's Advisory Committee on Supersonic Transport.

Dr. Brown did acknowledge a possible application when he indicated that if the SST is developed there may be enough specialized missions to warrant the purchase of a very small number for military usage. There are others who see an even greater requirement.

²Ibid., p. 217.

General Laurence S. Kuter, USAF (Ret.) who organized the Military Air Transport Service and led MATS throughout the Berlin and Korean airlifts, recently stated:³

The SST could revolutionize the capabilities of the U.S. Strike Command--the plan for transporting large, fully equipped battle units from their home bases in the U.S. to any point in the world, swiftly on short notice, to cope instantly with any military eventuality.

Gen. Kuter continued with two examples:

Only 50 SST's . . . could move a Divisional Battle Group with full individual equipment from Texas to Germany in a single day. And . . . in any month those 50 airplanes unassisted could move a full Airborne Army of three divisions with all but its heaviest and bulkiest equipment from Kentucky to India. . . .

The Commander of the U.S. Strike Command apparently agrees with General Kuter in regard to the military value of an SST. According

to Aviation Week,⁴ General Paul D. Adams, Commander, U.S. Strike Command, believes the supersonic transport would have great military value if it can be designed to land on standard-length runways.

Aviation Week quotes General Adams as follows: "I believe in speed and mobility," Gen. Adams said last week. "If it can be obtained without paying an unreasonably high price--such as (requiring) extraordinarily long runways."

The Strike Command will not have to pay that high price. A design requirement was established at the outset of the program for

³Laurence S. Kuter, "Auxiliary to Common Defense--Civil Aviation," Sperryscope, Third Quarter 1964, p. 2.

⁴Army SST Backing, Aviation Week and Space Technology, 20 Sep. 1965, p. 40.

the SST to be capable of operating from the airports currently used by the large subsonic jets. The FAA Administrator, General W. F. McKee, USAF (Ret.), recently attested to the capability of current designs to meet this requirement. In testimony before Congress, he stated:

The supersonic transport must be able to operate safely from today's airports which accomodate the large subsonic transport. In other words, we do not anticipate a requirement for extending runway lengths and both Boeing and Lockheed designs meet this criteria.⁵

The ability to move troops and equipment rapidly to any point on the globe especially at the outset of a low or mid-intensity conflict is of great importance to the United States and the Free World. In discussing military airlift requirements, General Harold K. Johnson Chief of Staff, United States Army, made the following statement in October 1965:

In the early phases of an operation the emphasis is on rapid deployment of troops. Airlift and preposition are of the utmost importance. Troops are flown to the objective area and marry up with prepositioned equipment.⁶

With the SST, troops could be made available to Europe as well as other parts of the world in a matter of hours. Each aircraft could carry approximately 200 fully equipped troops at 240 pounds each. Flight times would be cut at least in half and in most cases by more than half. To grasp the significance of this capability, the

⁵Congress, Supersonic Transport, p. 9.

⁶Harold K. Johnson, General, Chief of Staff, U.S. Army, Statement Prepared for Special Subcommittee on Military Airlift, 22 Oct. 1965, p. 4.

following indicates the time savings for a few international examples:⁷

<u>FROM</u>	<u>TO</u>	<u>TODAY</u>	<u>SST</u>
Washington	Paris	7 hrs 5 min	3 hrs 55 min
New York	Tokyo	13 hrs 50 min	6 hrs 6 min
New York	Rome	8 hrs 15 min	3 hrs 17 min

The capability of the SST for extremely rapid deployment of troops coupled with the capability of the C-5A for airlifting out-size cargo could provide an airlift potential of tremendous importance. The subsonic C-5A will have the capability of carrying 98 percent of all equipment issued to an Army division and related support units--M-60 heavy tanks, helicopters and missiles.⁸

The SST and C-5A operating as a "team" would be able to rapidly move troops and large quantities of out-sized cargo long distances, economically. Such a capability would greatly increase Air Force and Army mobility, reduce reaction time and thereby strengthen the Nation's capability to meet crises wherever and whenever they may occur.

The potential C-5A/SST team capability may also lead to a reconsideration of the need for heavy prepositioning of men and material overseas. With a C-5A/SST capability, it is conceivable that both troops and equipment could be reduced in overseas areas. Not only would this provide greater flexibility of ready forces based in the U.S., it would have an appreciable effect on relieving the gold flow problem.

⁷FAA, SST Q & A, p. 2.

⁸U.S. Air Force, Information Sheet, C-5A, Nov. 1965.

The supersonic transport operating in conjunction with the C-5A could prove to be a very effective peacekeeping weapon in the Nation's arsenal.

CHAPTER 6

IMPACT ON THE ECONOMIC ELEMENT OF NATIONAL POWER

A healthy, growing economy has an important relationship to national strength. The power, objectives, policies, and strategy of a nation depend in large measure on its economic system and how effective it is. There must be a balance in the allocation of human and material resources. The United States could find its national interest and type of society threatened if adequate resources are not utilized to insure economic growth.

The aircraft and airline industries have contributed significantly to the economic growth of our Nation, both directly and indirectly. The direct contribution has been in terms of GNP, jobs, and exports whereas the indirect economic benefits are realized through man's continuing effort to conquer distance and time and thereby "shrinking" the world for commerce and communications.

Today, the United States maintains international leadership in air transportation. Most foreign carriers buy U.S. equipment to stay competitive.

The following table based on aircraft in service at the beginning of 1963 is representative of the penetration U.S. products have made in free world transport aircraft fleets:¹

¹U.S. Congress, Senate, Aviation Subcommittee of the Committee on Commerce, United States Commercial Supersonic Aircraft Development Program, p. 59.

	<u>PISTON</u>	<u>TURBOPROP</u>	<u>JET</u>
U.S. Manufactured	97%	29%	81%
All Other	3%	71%	19%

The U.S. had almost complete dominance in the piston field, lost some ground to foreign-made turboprops, but has come back strong with the jet transports. The pressing questions today are-- what share of the market will the U.S. have when the supersonic transports are introduced and who will command international leadership in air transportation?

Civilian aircraft have always been a significant factor in total exports. During the SST Senate Hearings in October 1963, an official of the Department of Commerce indicated that transport aircraft contribute to our trade balance in "a most substantial amount. The DC-8 and 707 program alone were substantial contributors to our balance-of-payments situation."²

The purpose of this Chapter is to examine the impact of the supersonic transport on the national economy with specific emphasis on the balance of payments problem.

NATIONAL ECONOMY

The price of each SST will depend in large measure on the type of program that is finally established. The FAA, at this time, estimates that each SST will cost between \$25 million and \$30 million.

²Ibid., p. 316.

The manufacturers estimate that approximately 60 percent of the value of the production program would be divided among approximately 10,000 subcontractors, suppliers, and vendors in forty-six states. It is further estimated that the program will provide jobs for about 50,000 people throughout the country over a 20-year period.³

Assuming 400 SST's are manufactured and sold, the airframe and engine manufacturers will register over \$10 billion in sales. If the market reaches 800 aircraft, which is rather conservative when compared to the Department of Commerce estimate, the total sales would exceed \$20 billion. In addition, the U.S. airlines, with a potential return on investment of 20 to 30%, would be expected to generate billions of dollars in revenues. At this rate of return on an enormous investment, the earning power of several hundred SST's over a 15 year investment life is staggering.

And all of these dollars accruing from sales and revenues will be spent and re-spent throughout the economy. Many billions of dollars of taxes would also accrue to the Government.

The impact of the SST program on the U.S. balance of payments situation could also be significant.

BALANCE OF PAYMENTS AND INTERNATIONAL COMPETITION

The adverse U.S. balance of payments has amounted to \$3 billion to \$4.2 billion per year since 1958 and was about \$3 billion in 1964.⁴

³FAA, SST Q & A, p. 6.

⁴William B. Dickinson, Jr., "World Monetary Reform," Editorial Research Reports, 15 Mar. 1965, p. 189.

Although some improvement is expected in 1965, the problem remains one of great concern to the President of the Nation.

The President has approved certain changes in government balance of payments policies for implementation in 1966. He has indicated that recent programs had been effective in reducing the overall deficit in the U.S. balance of payments in the first three quarters of 1965 to an annual rate of \$1.3 billion--less than half the deficit in 1964. Still not satisfied, the President stated that "we have to show the world that we can bring our accounts into sustainable balance, and keep them in balance."⁵

There are many facets to the balance of payments situation. The trade balance--exports versus imports--is only one. Although we enjoy a favorable imbalance in trade, a widening of this gap through increased export volume may be one of the most effective means of reducing the deficit in total balance of payments.

The Secretary of Commerce recently emphasized the importance of expanding our exports. Speaking to the National Export Expansion Council on October 18, 1965, he said that in line with President Johnson's call for a redoubling of efforts to expand exports, U.S. firms should step up their trade promotion activities in order to develop broader markets for their goods.⁶

⁵"Revisions in U.S. Balance of Payments Program," International Financial News Survey, 17 Dec. 1965, pp. 461-462.

⁶U.S. Department of Commerce, International Commerce, 25 Oct. 1965, p. 3.

In order to examine the export potential of the supersonic transport, it must be viewed in light of international competition where exports can be weighed against imports. Although the U.S.S.R. is apparently moving ahead with the development of a supersonic transport, the primary competition is expected from the British/French Concorde.

The potential of the Soviet entry should not be dismissed lightly, however. Recently there has been an apparent switch from an expected approach of flying "first with anything" to an SST designed for low fares.

Early in November 1965, Wayne N. Parrish, Editor-in-Chief of American Aviation, interviewed Soviet designers in Russia in an attempt to get official and authentic answers concerning the Soviet program. Parrish reports that according to Andui Tupolev, designer of the TV-144 supersonic transport, they are designing the aircraft for a flight cost no greater than that of a modern subsonic transport. The Mach 2.2-2.3 TV-144 will carry 121 passengers 4,030 miles and is scheduled to fly in 1968 and be operational by 1971, almost simultaneously with the British/French Concorde.⁷

The Concorde is also smaller than the two U.S. proposed designs and will operate at Mach 2.2. The passenger capacity will probably range from 118 to 132 according to the FAA.⁸ Pierre Satre, however, recently indicated 140 passengers.⁹

⁷"Soviet SST Designed for Low Fares," American Aviation, Dec. 1965, p. 14.

⁸FAA, SST Q & A, p. 7.

⁹Edgar E. Ulsamer, "Prestige and Profits--The Stakes in the SST Race," Air Force and Space Digest, Jan. 1966, p. 46.

With the greater payload/range capability, 200-250 passengers over 4,000 miles, the U.S. designs should have superior economic characteristics. The economic potential of the U.S. designs were based on a 50% load factor for international operations which means revenue from 100-125 passengers. The Concorde at 50% load factor obviously would not be as attractive. The significant factor, however, is that the Concorde will probably operate for several years without U.S. competition and with a great demand for seats. With an unusually high load factor, which has a tremendous leverage on profitable operation, it is conceivable that the Concorde could show a rate of return during the non-competition years which would be greater than the U.S. design computed at an average 50% load factor. This prospect of potential earning power plus the fact the airlines must buy Concordes to remain competitive could have a substantial effect on U.S. sales and the balance of trade.

A successful U.S. SST program, however, one that is not too far behind the Concorde, would save or make approximately \$15 billion in foreign exchange.

If there is to be no U.S. SST, then U.S. airlines will be forced to buy Concordes. According to the FAA, various studies have shown the amount to be \$4 to \$5 billion. However, with a U.S. SST in production, foreign airlines would be expected to buy about half of the total U.S. production.¹⁰ Based on the previous market estimates, this could be \$5 to \$10 billion.

¹⁰FAA, SST Q & A, p. 7.

The total differential, or impact on our balance of trade, could therefore be in the order of \$15 billion.

As of July 1965, the proposed U.S. design held a commanding lead over the Concorde in delivery position reservations made by the airlines. In the U.S., delivery positions were secured by a deposit of \$100,000 as an advance royalty for each position.

Seven U.S. Companies have reserved 44 positions and fourteen foreign flag carriers hold 52 positions for a total of 96 for the U.S. SST. By comparison, four U.S. airlines hold 21 and six foreign carriers hold 26 positions for the Concorde for a total of 47.¹¹

¹¹Ibid., pp. 19-20.

CHAPTER 7

DISCUSSION

There are still many technical considerations associated with the development of a safe, economical U.S. supersonic transport that will require continued effort and cooperation of industry and the Government. Sonic boom, noise, economical producibility of an all-titanium structure, the production of subsystems and non-metallic materials for long life at elevated temperatures and the actual airframe-engine matching are probably the most important at this point. The design and production problems will not be easy and represent a serious challenge.

Outside the technical area, the major unresolved problem is the matter of financial participation of the Government and industry during the development of the transport. Cost sharing, as a guiding principle of the program, has been accomplished to date. The manufacturers must continue to absorb a reasonable share of the development cost but at the same time be protected against catastrophic loss. It is obvious that the financial plan which will ultimately be adopted must be fair to all parties concerned--the manufacturers, the airlines, and the taxpayers.

In regard to the state of technology, the FAA Administrator has indicated, at this point in the program, they do not see any technical problem associated with the transport which cannot be overcome through intensive effort. Technical problems, of course, will inevitably occur in a program such as the supersonic transport where success

will be measured not only on the ability to fly a specified mission but on the ability to do it economically. At this stage of design where technical and economic feasibility have been indicated through a comprehensive evaluation, the exact nature of any specific problem can best be determined through a prototype program. In discussing the possibility of reaching certification sooner than 1974, the FAA Administrator also stated that it was equally possible that the time period be delayed should technical problems be encountered which require more time.¹ The sooner these problems are identified the sooner solutions can be developed and delays prevented.

Some technical progress will undoubtedly be made during the 18-month program of continued design effort. For example, prototype test engines will be fabricated and some knowledge will be gained. However, only detailed proposals are required for the construction and qualification of flight test status engines for the prototype aircraft.²

Obviously, the flight test status engine would not be started until the prototype aircraft design was selected. The question naturally arises as to why 18 months before a decision to proceed with a prototype. Greater progress will be made when funding goes to one airframe company and one engine company. For a given amount of funds, the effort is diluted with two competing airframe companies and two competing engine companies, and the total program may be delayed.

¹Congress, Supersonic Transport, p. 14.

²Ibid., p. 35.

On the other hand, the Committee may feel that more reliable judgements may be forthcoming in regard to the relative merits of the competing designs. It is obvious that the President's Advisory Committee, under the Secretary of Defense, was not satisfied with the evaluation team findings although the team was composed of some of the best experts from Government agencies including the Air Force and the Navy.

The 18-month design effort represents a rather cautious approach. It may be too cautious.

During the hearings in August 1965, Congressmen repeatedly attempted to find a reasonable justification for the 18-month extension. "Hard" facts to support such a course of action were not forthcoming. FAA officials spoke in generalities in regard to the fact that the Committee had so decreed the extension, and that some benefits would accrue from further design efforts.

In analyzing the testimony, there was only one generality attributed to the McNamara Committee that could possibly offer a plausible explanation--provided it could be backed up by specific examples. In offering some justification for the extension, the Committee indicated that future work on the basic technological problems was required. But there were no specifics spelled out. The FAA has announced none. In fact, both the former FAA Administrator and current Administrator have testified to Congress that there were no significant technical problems that could not be overcome. Both statements were made as a result of a comprehensive Government evaluation of specific design proposals--one statement

made before the announcement of the 18-month extension and the other after the announcement.

Surely some technical problems exist, and there will be problems all the way through development. But at this stage of design progress, attempts to resolve all technical problems prior to the start of the prototype is a cautious approach that could result in a serious delay.

But if we assume that the Administrators were correct, the real reason for the extension becomes a little hazy. It must be conceded, however, that there could be factors other than technical involved. Certainly, the Committee is in the best position to weigh these in relation to proceeding with the SST program at a given point in time. It is possible that the C-5A and the Concorde may have influenced the judgement.

The second evaluation of specific SST design proposals was completed in December 1964. The announcement on results in January 1965, indicated technical and economic feasibility but did not mention either the Boeing or the Lockheed design. Both Boeing and Lockheed, as well as Douglas, were also competing at the same time on the multi-billion dollar C-5A contract which was scheduled for award in the summer of 1965, shortly after one or both specific SST designs were found acceptable. Since two companies were competing for both the SST and the C-5A, the possibility existed that one could be the winner of both. The possibility existed also that one of the two SST competitors would get the SST contract and the other the C-5A contract immediately thereafter. In any case, it would be impolitic

for the Secretary of Defense to announce "back-to-back" decisions on two major aircraft contracts in which two companies were competing for both.

Extending the SST design phase 18 months and thereby delaying the decision to select a contractor for the SST prototype program may have solved a problem for the Committee--but it is not yet clear whether the decision has solved or created problems for the SST. From a technical standpoint, such a course of action would naturally be questioned in face of the results of the Government's evaluation of specific designs. Under these circumstances, denial of the credibility of the evaluation, although never announced, was apparent when the Committee concluded that 18 more months were required before starting the prototype phase.

The 18-month extension of design effort on the SST, announced on 1 July 1965, precluded a contract situation that could have brought on criticism. The C-5A contract could be awarded on schedule, the SST decision was put off until January 1967, and the 18-month SST program represented a "step-up", albeit with four contractors each competing at about \$3 million per month compared with the first 12 months at about \$1 million per month. At any rate, the originator of such a course of action was probably well rewarded.

The so-called "step-up" in the program, however, should be examined in more detail. Some representatives of the airlines, who have been deeply involved in the SST program from the outset, interpret the 18-month program as something other than a step-up.

According to Aviation Week, William Littlewood, American Airlines consultant and former vice president, said he was disappointed with the 18-month extension and that six months, and certainly 12 months at the most, was enough extra time, before deciding whether to go into prototype. Aviation Week also reported that Ray D. Kelly, United Airlines Technical Development Director, agreed that the pace should be quickened. According to Kelly, the French-British Concorde is proceeding smoothly with the objective of achieving the greatest possible time advantage over any U.S. entry. He was at the Concorde plant in France at the time of the announcement of the U.S. 18-month program and said the French were delighted.³

Competition with the British and French brings up the third factor that the Government must consider in determining the pace of the U.S. program. Without a substantial time advantage on entry into airline service, the Concorde could not compete with the U.S. SST because of the superior economic characteristics of the U.S. product. Therefore, if the objective of the U.S. program were to minimize the time advantage of the Concorde, it is possible that the British and French would have to terminate development or phase-out production early at a substantial financial loss to both nations. Such an eventuality will not be taken lightly by the British or the French or the U.S. It is important to the U.S. that the economic base of important North Atlantic Treaty allies be strengthened rather than weakened. On the other hand, a serious delay in the U.S. program could result in a

³"Faster SST Pace," Aviation Week, 23 Aug. 1965, p. 25.

major economic loss in terms of jobs, GNP, and balance of payments, as well as a loss technologically and psychologically, and the possibility of no military SST.

A compromise appears extremely difficult because of the forces of international competition which cannot be controlled. The crux of the problem is how far behind is the U.S. product and how long will the airlines wait for a superior product. The announced commercial service date of the Concorde is early in 1971, or perhaps 1970. The certification date of the U.S. SST is estimated for the 1973-1975 time period.

According to the FAA, if the U.S. SST is more than two years behind, it may be possible for the Concorde to penetrate the market potential to a greater degree than now anticipated and consequently, reduce the potential for the United States transport.⁴ The airlines will be forced to compete with whatever supersonic transport is available, and orders must be placed now to insure a competitive position. The airlines need assurances that there will be a complete U.S. program with certification at the earliest possible date.

With the announced schedules, it is possible for the U.S. to be anywhere from 3 to 5 years behind, with the strong possibility of at least 3 years. The Concorde, with no U.S. competition, will enjoy a very high return on investment based on an unusually high load factor. A very high return for several years will allow rapid depreciation.

⁴FAA, SST Q & A, p. 7.

With a quick "write-off" of depreciation expense, the Concorde would then have attractive economic characteristics even at normal load factors of approximately 50%. When the U.S. product does appear, some traffic will naturally be drawn away from the Concorde reducing its load factor to perhaps the normal range; but with rapid depreciation attainable through several years of non-competitive operation, the Concorde could still be economically attractive in competition. This factor may influence the airlines to buy more Concordes in an effort to capture the market; and they can stay with one type of equipment. The U.S. market potential would therefore be reduced.

As the potential U.S. market goes down, the sales price and pro rata development royalty go up and the economic characteristics deteriorate. This prospect enhances the potential of the Concorde relative to the U.S. SST. Such a vicious cycle could result in the failure of the U.S. program.

The U.S. is, therefore, faced with a dilemma. If we move ahead expeditiously without delay, the British and the French may suffer a financial loss due to international competition. If we attempt to compromise, the possibility exists that the U.S. could be the substantial loser. The stakes are extremely high because of the financial risk of such a program and the significance in terms of national power that may accrue to a nation with a successful program. In international competition, timing could be as important as a minor difference in relative merit of two products.

It is not at all certain that there could be two winners. The U.S. cannot risk being the loser. Timing is the only adversary.

Firm policy to move ahead expeditiously with a prototype/production program, timely funding support from Congress, and efficient program management can defeat the adversary.

CHAPTER 8

CONCLUSIONS AND RECOMMENDATIONS

Development of an economically viable supersonic transport on a timely basis is required to maintain United States international leadership in air transportation. Important benefits in the national interest will flow from such a position of technological preeminence.

The supersonic transport will have a significant impact on all basic elements of national power--economic, military, political/psychosocial, and technological. Quite conceivably, the nation can derive more benefits in terms of the broad aspects of national power from the supersonic transport than from any other single project undertaken by the Government. The significant impact on the national economy and the balance of payments, the military application, and the favorable effects psychologically and technologically are the more important tangible benefits. And all of these can be obtained at no cost to the taxpayer.

An orderly, deliberate national undertaking can produce a supersonic transport which could become the finest transport in the history of aviation--a transport that could:

- Strengthen the strategically and economically vital United States aerospace industry. With a conservative market estimate of 400 aircraft, the value of the production program would exceed \$10 billion with jobs for over 50,000 people throughout the country over a 20-year period. Over 60% of the total production

program would be conducted by companies other than the prime contractors.

- Offer to the world's airlines a safe, economically viable, long-life transport which can provide a return on invested capital of 20 to 30% at current fare levels.

- Provide a favorable net balance of payments over the production life of the transport in the order of \$15 billion.

- Strengthen the national military airlift capabilities by cutting at least in half the flight times required to transport fully equipped troops to any point in the world, on short notice to cope instantly with any military eventuality. Teamed with the C-5A to transport the outsized, heavy Army equipment, the greatest airlift capability in the world would be realized. The credible flexibility that could be maintained for ready forces based in the U.S. would have a significant effect on worldwide commitments of prepositioning equipment and manpower.

- Provide a highly productive, Mach 2.7 vehicle with a range/payload capability of over 40,000 pounds at a distance of 4,000 miles which would have many possible military applications.

- Demonstrate the technological and production capabilities of the United States as a powerful symbol in a world characterized by political, technological, and commercial competition among national systems.

- Mark a major step forward in "shrinking" the globe as a means of enhancing worldwide commerce and communication.

The benefits outlined above will be achieved by the United States only through a successful program, not only successful from a design and production standpoint, but one which is conducted on a timely basis because of formidable international competition. With the great importance of timing, it is recommended that the U.S. supersonic transport program be accelerated. If practical, a single design, one airframe contractor and one engine contractor, should be selected prior to the end of the current 18-month program to immediately proceed with a prototype program. In any case, target date for airline service should be no later than 1973.

In view of the strong indication of military potential, it is further recommended that a comprehensive study in depth be made to determine the various military applications of the supersonic transport. The study should be made by a team from Air Force Systems Command, Military Airlift Command, and the U.S. Strike Command with performance and operational characteristics of the transport furnished by the Federal Aviation Agency.

Donald I. Hackney
DONALD I. HACKNEY
Lt Col USAF

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